

### Spawning, egg, and juveniles... Continued

hatchery production levels have been marginally effective in overcoming some of these mortality factors. Planning studies for additional offstream storage and new hatchery facilities have been initiated but will not be completed within the time frame of this Plan. The following actions have potential to increase the number of juvenile salmon produced from the next five generations which survive to the next life stage:

- a. Develop and implement measures to maintain water temperatures in the spawning reaches at adequate levels October 15 through mid-March and for juvenile rearing reaches particularly in April and May.

See Actions 2.b. and 2.i.

- b. Develop additional instream flows to augment existing schedules.

See Actions 2.a. and 2.c. above.

- c. Produce an acceptable number of hatchery yearling salmon when trapping and hatchery programs are used.

Similar to Action 2.h. this action includes the trapping of adults to obtain eggs for hatchery programs, or the recovery of naturally produced salmon (fry, juveniles and smolts) which are then maintained in a hatchery. A variety of products (sizes of fish) are produced in hatcheries to be released back into the wild. Examples are smolts (70-90/lb juveniles) or yearlings (6-10/lb juveniles). Yearlings remain in the hatchery longer, are larger at release, and because they migrate to the ocean and reach legal size later they generally avoid some of the natural and harvest mortality. The result is a greater contribution to escapements than fish released as smolts. Yearlings have a slightly greater tendency to return to spawn as two year olds resulting in less recruitment to subsequent generations. All considered, doubling the contribution rate of hatchery products to escapements by using yearlings the next few years may be a useful measure to speed recovery of adult salmon numbers.

- d. Increase survival-to-emergence and improve rearing habitats.

Accelerate planning and construction of priority habitat improvement projects in the spawning and nursery areas. More than \$1 million has been expended on habitat improvement project on spawning tributaries

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in the San Joaquin drainage since 1988. Funding has been secured for Department of Water Resources to design ten additional projects over the next few years and funding for construction is available through the Delta Pumping Plant Protection Agreement. Funding for additional habitat work is available from other State and Federal sources. It should be recognized that although these projects can provide incremental benefits in the short term the full potential of habitat improvement efforts cannot be met until (1) the spawning escapements recover to the point where habitats (spawning and nursery) can be fully "seeded" each year, and (2) adequate streamflows and protection from diversions are in place.

### e. Reduce predation mortality.

Encourage harvest of un-naturally high concentrations of predators from the spawning and rearing reaches.

Feasible control efforts could be pursued where un-naturally high predator densities exist. Recently the Merced Fly Fishing Club assisted the Department of Fish and Game in removing non-game fish from the Merced River salmon spawning area. Fish removed were utilized by the local Southeast Asian Community. Efforts such as these provide only minor temporary benefits but may help. Improvements in habitat and streamflow conditions that favor cold water species instead of predators will be most effective in the long term. Actions 2.a., 2.b., 2.i., 3.a., and 3.b. all provide opportunities to help reduce predation mortality in this manner.

Low summer flows tend to encourage larger predator populations which are then present when young salmon emerge and rear. Actions that increase cold water habitat conditions through the summer months in the nursery reaches may be beneficial.

Artificial structures or features that concentrate predators could be eliminated where possible. Dennett Dam on the Tuolumne River, old bridge footings and piers, irrigation diversion structures (e.g., pilings to support pumps) all tend to concentrate predators.

Old gravel pits in the river channel support significant predator populations. Habitat improvement projects under Action 3.d. can result in reduced

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predation mortality as well as improved rearing habitat and water quality (e.g., temperature).

- f. Evaluate and encourage conjunctive benefits of domestic water supply projects.

State and Federal grant, loan and mitigation programs and other incentives could encourage domestic water supply projects to utilize the natural channels (salmon spawning and rearing reaches of the San Joaquin tributaries) as the primary conveyance channels. Domestic water supply projects may provide opportunities to benefit multiple uses without significant additional cost. Water quality, quantity and cost-benefit are important factors to consider on a case-by-case basis.

This Action would provide complementary benefits to many other Actions listed in this Plan.

- g. Accelerate evaluations of the impact of different types of diversions (e.g., siphons, pumps, etc.), and install protective devices (e.g., screens, electrical fields, etc.) on priority agricultural or other diversions within the nursery and migration reaches.

The Department of Fish and Game and the Department of Water Resources have study programs underway to determine fish losses associated with various types of diversions. These studies should be evaluated to ensure that the results will be directly applicable to the types of diversion impacts occurring in the San Joaquin drainage. A quick review of water rights and points of diversions along the 50-plus river miles on each tributary indicates that many diversions in the primary nursery areas are made by small pumps. The main exceptions are on the Merced River where riparian water is diverted by gravity flow into screened ditches.

Larger diversions (up to 250 cfs) occur along the main San Joaquin River where rearing generally occurs only in wet and above normal years when flows are high, water temperatures are cool and fry are dispersed well downstream. Screening to protect outmigrating smolts is addressed in Action 4.

Fish screens or other protective devices could be installed on priority diversions as screening technologies are identified, and the funding

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responsibilities to install, operate and maintain them are defined. Installation without commitment for maintenance should be avoided.

- h. Accelerate planning studies for additional offstream storage and conjunctive use programs which benefit protection of salmon habitats.

The benefits of this effort may not be attainable within the time period of this Plan. However, these studies can improve our understanding of the opportunities using existing project features and help foster proactive problem solving.

See Action 2.a.

- i. Continue planning and design studies for hatchery supplementation of natural salmon populations.

Use of the Tuolumne River Rearing Facility (Modesto I.D. abandoned main canal section near La Grange) and Merced River Fish Facility should continue while planning for additional supplementation proceeds. Although these existing facilities have not been operated to capacity for some time due to the low abundance of eggs, history tells us that this stock can rebound quickly. If appropriate planning and environmental analysis proceed over the next five years, additional supplementation capabilities could be available when the populations rebound from their current depressed status. Thereafter supplementation in combination with improved habitat and instream flows could help avoid serious depression in future droughts.

4. Smolt and yearling outmigrations High mortality during outmigrations is believed to be caused by high predation rates, low streamflows, high water temperatures, poor or no screens on water diversions, flow reversal and high export rates in the Delta and other factors. Losses occur in the nursery tributaries, along the mainstem San Joaquin River above Vernalis, and in the Delta. Again, a suite of actions that improves survival in each segment of the outmigration route will likely provide the greatest benefit. The following Actions have potential to increase the number of San Joaquin salmon smolts safely reaching the Pacific Ocean:

- a. Augment existing instream flows in the nursery tributaries in April and May.